SOME BIOLOGICAL STUDIES ON PERFORMANCE OF NILE TILAPIA *(OREOCHROMIS NILOTICUS)* FED ON DIFFERENT DIETS

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Abstract

Net fish production and growth performances of Nile tilapia *(Oreochromis niloticus)* were studied in ponds treated either with complete feed alone, supplementary feeding alone or a combination of complete and supplementary feeding compared to a control (natural feeding) treatment. Four treatments were applied in this study, each treatment was carried out in two pond replicates, 1000 m^2 (50 × 20 m) each and one meter water column. The first treatment received complete fish feed (22% protein)at a rate of 3 % daily of fresh fish body weight (T1). The second treatment received supplemental feeding cattle feed (11% protein) at a rate of 3 % daily of fresh fish body weight (T2). The third treatment received complete fish feed plus supplemental feed at a rate of 1.5% daily of fresh fish body weight.The fourth treatment (control) (T4) did not receive any commercial feed (natural feeding). Final weight of tilapia averaged 193.4, 138.02, 167.3 and 110.79 g / fish in the complete feed (fish feed) alone, supplementary feeding (cattle feed) alone, complete and supplementary feeding and natural feeding ponds, respectively. Net production of tilapia averaged 530,1, 376.5, 457.7, and 298.89 kg/pond in these extensive fish culture treatments, respectively. Results indicated superior tilapia growth and total production in complete fish feed ponds. This system may be recommended for extensive local fish farming.

INTRODUCTION

Aquaculture would contribute partially in the increased demand for animal protein consumed by human. In the recent years, great attention has been paid to initiate fish farms. Because human consumption of high protein foods is gradually rising, its demand is not likely to be covered by livestock production and by development of natural fisheries. Higher fish yields could be obtained by applying supplemental feeds.

However, for intensive fish production, compound feeds which have the proper ratio of energy and proteins and provided, with vitamins and minerals, should be used. Best feed conversion ratio of 1.6 was achieved by common carp using pellets containing 25% protein in demand feeders at stocking rates of 5000 fingerlings per hectar under conditions of improved feeding (Kruger, 1978). The importance of artificial feeding was studied by many authors. Lam and Shephard (1988) found that common carp growth in tanks supplied with both natural feeds and a high protein supplement was very variable, and detected that fish growth was influenced by the presence of natural feed. Since feed costs represent an important part from the production costs., it is necessary to identify alternative protein sources to reduce or stabilize the cost of production. For feeding fish, the optimum amount of protein from different sources in formulated feeds is very important for optimum growth. As well excess protein in fish diets may be wasteful and causes the diets to be expensive. There are a linear relationship between the percentage of protein in the diet and the increase in fish weight up to optimal level of 43 – 50% as reported by several authors (Abdel – Fattah, 2002, Shuenn *et al.*, 2002 and David *et al.*, 2004).

The present work aims to study the effect of three feeding regimes on growth and physiological characteristics of tilapia in earthen ponds, as compared with natural feeding (control treatment).

MATERIALS AND METHODS

Eight stagnant fresh water earthen ponds, 1000 m^2 each and one meter water column, located at the Central Laboratory for Aquaculture Research (CLAR) Abbasa, were used from 1st June – 31 October 2002 (153 days) to study the effect of using complete and supplementary feeding on fish growth. Flushing the ponds with fresh water was allowed periodically (monthly) to compensate only for the water loss throughout seepage and evaporation. Four treatments were applied in this study, each treatment was carried out in two pond replicates. Each pond was fertilized two weeks with 7.5 kg triple superphosphate and 2.55 kg ammonium sulphate, plus 7.5 kg duck droppings. Each pond included 3000 Nile tilapia *(Oreochromis niloticus).* Average fish weight at the experimental start was 40 g. The first treatment received commercial complete pelleted fish feed containing 22 % CP and fed at a rate of 3 % daily of fresh fish body weight. (T1). The second treatment received supplemental feeding cattle feed (11 % CP) and fed at a rate of 3% daily fresh fish body weight (T2). The

third treatment received complete pelleted fish plus supplemental feed at rate of 1.5% daily of fresh fish body weight. The fourth treatment (control) (T4) did not receive any commercial feed, but having natural feeding. The chemical analysis of pelleted and supplemental fish feed used in the experiment is presented in Table 1. Water quality was monitored at sunrise for temperature dissolved oxygen (DO), PH, total alkalinity, total hardness, orthophosphate, and chlorophyll (a) concentrations. Samples of pond water (8 samples) were taken on the 7^{th} day intervals following fertilization. Samples were collected (one liter/ pond) from four constant sites (outlet, inlet and mid pond) at two depths in water (at surface and at 25 cm depth). Thereafter, samples were analyzed in the laboratory according to Boyd (1992). Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined in samples of fish livers from each treatment according to Reitman and Frankel (1957). Plasma cholesterol was determined by kits (Biocon D- 57299 Burbach / Germany). Blood was then drawn from caudal ventral sinus according to Watson (1960). Tissue cholesterol was determined by hemoginizing one gram in 20 ml potassium chloride, then centrifuged at 7500 rpm for l0 min. The assay was carried out in 0.1 ml from the supernatant by the same kits used for cholesterol assay in plasma. Fish body analysis was carried out at the end of the experiment on three fish / pond according to Association of Official Analytical Chemists, AOAC (1995). Moisture was determined by drying samples in oven at 105 ^{o}C for 3.5 hours. Crude protein was determined by the macro kjeldahl method. Crude fat (ether extract) was determined by extraction with soxhlet apparatus. Ash was determined by using muffle furnace at 550 ^{o}C for 4.5 hours.

Weight gain was calculated as:

Weight gain = final mean weight – initial mean weight

Absolute growth rate was calculated as:

$$\text{Absolute growth rate (Daily gain)} = \frac{\text{weight gain}}{\text{experimental period in days}}$$

Relative Growth Rate (RGR%) was calculated as:

$$\text{RGR\%} = \frac{\text{Final weight} - \text{initial weight X 100}}{\text{initial weight}}$$

Specific Growth Rate (SGR%) was calculated as:

SGR% = (Lnwt – lnwo) 100 / t.

Where :

ln is the natural logarithm,

t = experimental period in days

wt = final weight. wo = initial weight

At the end of the experiment, ponds were drained and harvested. Fish yield was weighed and total production of fish was determined. Statistical analysis was carried out according to SAS (1985).

RESULTS AND DISCUSSION

Effects of complete and supplementary feeding on water quality

Data collected on water quality are presented in Table 2. Surface water temperature increased gradually up to the end of August, then, decreased. The range of recorded temperature (22.1 – 29.9 °c) was suitable for tilapia (Boyd, 1992). The present results agree with those obtained by Abd – ElMageed (1997) who found that temperature in Egypt in Nile tilapia ponds was 19 to 27 C (from June to November). The highest dissolved oxygen (Do) (3.99 mg / l) was obtained in ponds of treatment (T4), that with natural feeding, while, the lowest (Do) was recorded in ponds of (T1, T2, and T3), supplemented with feeding. Boyd (1992) postulated that excess feeding can result in an increase in organic material with increase in oxidation through metabolic processes by bacteria producing a decrease in DO. The pH value in experimental ponds was not significantly different ($P > 0.05$) among treatments. The values were always over 8. These values fall within the range stated by Knud -Hansen and Pautong (1993) who found that pH values in Nile tilapia ponds in Thailand were 8.2 to 8.9. The highest alkalinity (395. 52 mg / l) was obtained in ponds of treatment (T1), while, the lowest alkalinity (190.65 mg / l) was obtained in ponds of treatment (T4) that with natural feeding (control). It is considerable that the control was poor in chlorophyll (a) and phytoplankton, this confirms that high density of phytoplankton can lead to high alkalinity as studied by Hayes and Anthony (1964). Total hardness values (190.65-375.52 mg/l) are commonly encountered in natural waters (Boyd, 1992). Orthophosphate concentrations (0.32 – 0.62 mg / l) were relatively higher in comparison with the values obtained by Boyd (1992) in fertilized ponds (0.02 – 0.03 mg / l). Values of chlorophyll (a) (85.69 – 190.65 mg / l) were relatively to those reported by Boyd (1992) in fertilized ponds (109 – 134 mg / l).

Effects of complete and supplementary feeding on growth of fish

Effect of feeding regimes on fish growth are presented in Table 3. The highest final weight and weight gain of tilapia (193.47 and 151.47 g/fish) was obtained in the

treatment (T1) receiving complete feed at a rate of 3% daily (22% protein), while, the lowest final weight (110.70 g / fish) and weight gain (70.15 g / fish) were obtained in ponds with natural feeding (T4) ($P < 0.05$). These results indicated that tilapia growth increased with increasing percentage of protein in the diet. The present results are in agreement with those recorded by Chioma (1997) who found that *Tilapia galilaeus* growth increased with increasing percentage of protein in the diet. Abdel – Fattah (2002) found that Nile tilapia *(Oreochromis niloticus)* fry growth increased with increasing percentage of protein in the diet. The lowest relative and specific growth rates were obtained in ponds with natural feeding (T4). The highest relative and specific growth rates were obtained in the treatment receiving complete feed at a rate of 3% daily (T1). Differences were significant ($P < 0.05$) (Table 3). These results indicated that relative growth rate and specific growth rate of tilapia increased with increasing percentage of protein in the diet. The present results are in agreement with those of Chioma (1997) and Abdel – Fattah (2002) who found that (RGR%) and (SGR %) of tilapia increased with increasing percentage of protein in the diet.

Effects of complete and supplementary feeding on physiological characteristics

Effect of feeding regimes on physiological characteristics of tilapia are presented in Table 4. Assessments of both AST and ALT enzymes activity in liver of tilapia (Table 4) indicated that these enzymes activity increased gradually with increasing percentage of protein in the diet. The highest AST and ALT (130.55 and 55.91 u / 100 g tissue) in tilapia liver was found in the treatment receiving complete feed at a rate of 3% daily (T1), while, the lowest values (61.92 and 18.42 u / 100 g tissue) were recorded in the control group (T4), that with natural feeding. Statistical analysis showed that differences between treatments were significant($P< 0.05$) . This might indicate that, at increasing percentage of protein in the diet, liver function may be elevated to meet the more protein intake. In addition, increased enzyme activity may relate to the fact that enzymes are protein, and increased feeding rate of protein, amino acids may induce enzyme synthesis (EL – Sherbiny *et al.,* 1998). These results are in general agreement with those reported by (EL – Sherbiny *et al.* 1998) who observed that the activities of these liver enzymes increased with increasing percentage of protein in the diet. Tissue and plasma cholesterol content of tilapia (Table 4) indicate that cholesterol increased gradually with increasing percentage of protein in the diet. The highest tissue and plasma cholesterol (25.62 mg / g weet and 654.90 mg / dl) in tilapia was found in the treatment receiving complete feed at a rate of 3% daily (T1),

while, the lowest values (18.52 mg / g weet and 430.61 mg / dl) were recorded in the control (T4), that with natural feeding. Statistical analysis showed that these differences between treatment were significant ($P < 0.05$). Three factors probably contributed to these differences; increasing percentage of protein in the diet, high lipid content in the diet, and the specific type of dietary fat. These results are in agreement with those obtained by Farrell and Munt (1983) who observed that the tissue and plasma cholesterol increased with increasing percentage of protein in the diet.

Effects of complete and supplementary feeding on chemical composition of fish bodies

Means of chemical components of fish whole body for tilapia are presented in Table 5. The highest values of protein and fat contents were obtained in the treatment receiving complete feed at a rate of 3% daily (T1), while, the lowest values are those of the control group(T4), that with natural feeding. Ash content showed opposite trend to that of protein. These differences between treatments were statisticaly different ($P < 0.05$). The tissue water content in fish usually increases with decreased percentage of protein in the diet. This rise in tissue water runs parallel to the fall in tissue protein and lipid levels. However, the main part of the reduction must be due to a real mobilization of the tissue energy reserves (Love, 1970). These results agree with those obtained by Xueling *et al.* (1991) who observed that Nile tilapia receiving no feed showed reduction in the percentage of lipid and protein in their carcass with a concomitant increase in moisture and ash.

Effects of complete and supplementary feeding on the economic evaluation

Effect of feeding regimes on total production and the economic evaluation are presented in Table 6. The highest total production of tilapia (530.10 kg) was obtained in the treatment receiving complete feed at a rate of 3% daily (T1), while, the lowest total production (298.89 kg) was obtained in ponds with natural feeding (T4). These results indicated that total production of tilapia increased with increasing percentage of protein in the diet. The present results are in agreement with those of Chioma (1997) who found that total production of tilapia increased with increasing percentage of protein in the diet. The economic evaluation of the treatments revealed that the most economic system is providing complete feed at a rate of 3% daily (T1).

The net return (total return – total cost) was 1970.51, 1648.89, 1851.58 and 1574.03 L.E. / pond for T1, T2, T3, and T4 treatment, respectively, (Table 6). The best net return (1970.51 L.E. / pond) was obtained with T1. In conclusion, a system based on receiving complete feed (22%cp) a rate of 3% daily is recommended for local fish farming.

Table 1. Chemical analysis of complete and supplemental feed used in the experiment (in% dry matter basis).

Analyzed components	Percent	
	Complete feed*	Supplemental feed*
Moisture	11.20	8.28
Dry matter	88.80	91.72
Crude protein	22.02	11.00
Crude fat	10.64	4.57
Crude fiber	6.43	18.61
Ash	8.55	11.86
Nitrogen free extract (NFE)	52.36	53.96
Gross energy (kcal / kg)	4663	3298

- Commercial diet from local market.

Table 2. Limnological characteristics of water in experimental ponds (means ± S.E).

Parameter / Treatment	Temperature (°C)	Dissolved Oxygen (mg / l)	PH	Alkalinity (mg / l)	Hardness (mg / l)	Orthophosphate (mg / l)	Chlorophyll (a) (m g/ l)
T1	26.90^{a}± 0.74	3.99^{a}± 0.20	8.34^{a}± 0.10	395.64^{b}± 15.02	375.52^{a}± 19.20	0.62^{a}± 0.04	190.65^{a}± 8.20
T2	26.75^{a}± 0.55	3.64^{a}± 0.19	8.29^{a}± 0.11	339.15^{c}± 18.35	220.21^{c}± 12.19	0.51^{b}± 0.02	139.91^{c}± 9.29
T3	26.59^{a}± 0.42	3.51^{a}± 0.29	8.42^{a}± 0.05	480.52^{a}± 20.10	310.61^{b}± 25.12	0.48^{bc}± 0.11	164.22^{b}±10.25
T4	26.50^{a}± 0.40	3.44^{a}±0.12	8.10^{a}± 0.02	299.43^{d}± 14.22	190.65^{d}±10.11	0.32^{c}± 0.02	85.69^{d}± 6.21

Means within each column with no common subscript differ significantly ($P < 0.05$).

Table 3. Growth performance and total production of tilapia as affected by the different feeding treatments (Mean ± S.E.).

Item / Treatment	Initial weight (g / fish)	Final weight (g / fish)	Weight gain (g / fish)	Absolute growth rate (g / day)	RGR (%)	SGR (%)	Total production (kg / pond)
T1	42.0^{a}± 0.62	193.47^{a}± 5.50	151.47^{a}± 4.60	0.99^{a}± 0.10	360.64^{a}± 12.51	0.99^{a}± 0.17	530.10^{a}± 25.62
T2	40.10^{a}± 0.51	138.02^{c}± 6.52	97.92^{c}± 3.50	0.64^{c}± 0.12	244.19^{c}± 10.11	0.80^{c}± 0.05	376.51^{c}± 36.11
T3	41.90^{a}± 0.48	167.36^{b}± 7.22	125.46^{b}± 3.90	0.82^{b}± 0.16	299.43^{b}± 8.66	0.90^{b}± 0.16	457.72^{b}± 20.15
T4	40.55^{a}± 0.38	110.70^{d}± 4.95	70.15^{d}± 2.51	0.46^{d}± 0.01	172.99^{d}± 7.61	0.66^{d}± 0.12	298.89^{d}± 15.14

* Means within each column with no common subscript differ significantly ($P < 0.05$).

Table 4. Biochemical characteristics of tilapia as affected by the different feeding treatments (Means ± S.E.)*.

Item \ Treatment	T1	T2	T3	T4
Liver AST (u/ 100 g tissue)	130.55^{a}± 5.21	80.29^{c}± 3.66	98.42^{b}± 3.91	61.92^{d}± 2.90
Liver ALT (u / 100 g tissue)	55.91^{a}± 4.21	28.64^{c}± 2.12	40.92^{b}± 3.61	18.42^{d}± 2.11
Tissue cholesterol (mg/ g weet)	25.62^{a}± 0.51	19.42^{c}± 0.32	23.56^{b}± 0.41	18.52^{d}± 0.42
Plasma cholesterol (mg/ dl)	654.90^{a}± 52.21	495.65^{c}± 15.16	592.20^{b}± 31.20	430.61^{d}± 30.10

*Means in the same row followed by different superscript letters are significantly different ($P < 0.05$).

Table 5. Percentage of chemical components* of fish whole body of tilapia as affected by the different feeding treatment (Means ± S.E.).

Component \ Treatment	T1	T2	T3	T4
Dry Matter (DM)	25.92^{a}± 0.14	24.91^{b}± 0.11	25.15^{a}± 0.11	24.25^{b}± 0.17
Protein	68.46^{a}± 0.55	66.55^{c}± 0.75	68.12^{b}± 0.43	64.75^{d}± 0.88
Fat	22.35^{a}± 0.22	21.10^{b}± 0.34	22.15^{a}± 0.24	20.70^{c}± 0.29
Ash	9.14^{c}± 0.12	12.05^{b}± 0.14	9.10^{c}± 0.10	13.90^{a}± 0.18

a – d Between treatments the means followed by different superscript letters are significantly different ($P < 0.05$).

* DM% whole body.

Protein, Fat and Ash as % of DM.

Table 6. Profitability of different feeding treatments.

Regimes \ Item	Total production (kg/pond)	Total cost* (L.E./pond)	Total return** (L.E./pond)	Net return*** (L.E./pond)
T1	530.10	1475.14	3445.65	1970.51
T2	376.51	798.42	2447.31	1648.89
T3	457.72	1123.60	2975.18	1851.58
T4	298.89	368.65	1942.68	1574.03

* Total cost include: Feed cost, fertilizer cost, fingerlings cost, land rent, labor, machinary, intrest on capital and others.

** Total return = market value of Nile tilapia.

*** Net return = total return – total cost.

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دراسات بيولوجية على أسماك البلطى النيلى المغذاة على وجبات مختلفة

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تم تقييم الإنتاج السمكي الصافي وأداء النمو لسمكة البلطي النيلي في الأحواض الترابية بعد معاملتها بالتغذية الكاملة (علف سمك) فقط ، التغذية الإضافية (علف حيواني) فقط التغذية الكاملة بالإضافة إلى التغذية الإضافية ، وأخيراً عدم إضافة أي غذاء . أربع معاملات تم استخدامها في هذه الدراسة ، كل معاملة أجريت في حوضين مكررين مساحة الحوض الواحد ١٠٠٠ متر مربع .

المعاملة الأولي تم فيها تغذية الأحواض بالعلف الكامل (حبيبات سمك ٢٢% بروتين) بنسب يومية٣% من وزن السمك الكلي ، المعاملة الثانية تم فيها تغذية الأحواض بالعلف الإضافي (علف حيواني ١١% بروتين) بنسب يومية ٣% من وزن السمك ، المعاملة الثالثة تم فيها تغذية الأحواض بالعلف الكامل بالإضافة إلى العلف الإضافي بنسب يومية ١,٥% من وزن السمك وأخيراً المعاملة الرابعة أجريت بدون إضافة أي غذاء (كونترول) مجموعة ضابطة. بلغ متوسط الوزن النهائي للأسماك في نهاية التجربة[١٩٣,٤ – ١٣٨,٠٢ – ١٦٧,٣ – ١١٠,٧] جم في معاملات التغذية الكاملة فقط والتغذية الإضافية فقط والتغذية الكاملة بالإضافة إلى التغذية الإضافية وأخيراً الأحواض الغير مغذاة على التوالي . بلغ متوسط الإنتاج الصافي للأسماك في نهاية التجربة[٥٣٠,١ – ٣٧٦,٥ – ٤٥٧,٧ – ٢٩٨,٨ كجم / حوض] في هذه النظم على التوالي . أوضحت النتائج نمو متفوق لسمكة البلطي وأيضاً زيادة الإنتاج الكلي في أحواض المعاملة الأولي التي تم تغذيتها بالعلف الكامل بنسب يومية ٣% من وزن السمك . وهذه المعاملة أو النظام هو الذي توصي التجربة بإتباعه في مزارع الأسماك المحلية تحت نظام الاستزراع الغير مكثف .